Invasive Techniques Utilized in Chronic Pain Management

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Abstract

A multidisciplinary approach to the treatment of chronic pain has been one of the most effective means of restoring the ability of a patient to return to an increased level of function. Many techniques used for diagnostic and therapeutic means have been utilized as part of this approach. This paper will describe some of the more common invasive techniques used in the treatment of chronic pain.

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Pain management has received much attention in the media lately with discussions ranging from physician assisted suicide to narcotic use in the chronic pain patient. Treatment of the chronic pain patient is best accomplished with a multidisciplinary approach as pain is a complex multidisciplinary problem. Proper treatment will often require input and therapy from anesthesiology, medicine, neurology, oncology, physiatry, physical and occupational therapy, psychiatry, psychology, surgery, and nursing services. Some of the more common treatments which have been performed by the anesthesiologist will be discussed. These therapies include nerve blocks, epidural injections, dorsal column stimulators, and subcutaneous infusion pumps. Many of these techniques are used daily for surgical anesthesia or post operative pain management. They are also useful in treatment of various chronic pain syndromes. Invasive therapies are only one aspect of pain treatments, and other treatment modalities will not be described in this article.

The epidural space is a potential space between the dura and the ligamentum flavum and lamina. It is present from the foramen magnum to the sacrococcygeal membrane. Injection into the epidural space may occur between any of the vertebra down to the caudal space. Various medications have been injected into the epidural space for anesthesia and/or analgesia. These medications include local anesthetics, narcotics, steroids, Clonidine, neurolytic agents, autologous blood, and hypertonic saline to name a few. Injections can be performed as a one time injection, or an epidural catheter may be placed for continuous infusions. The indications for an epidural injection in the acute setting include: surgery, obstetrics, postoperative pain, fractured ribs, pancreatitis, frostbite, herpes zoster, ischemic pain, and post dural puncture headaches. Indications for chronic pain include: low back and cervical pain, postherpedic neuralgia, chronic regional pain syndrome, malignancy, phantom limb, and diagnostic or prognostic blockade.[1] Epidural injections are usually placed at the closest dermatome to the level which is involved with their symptoms. There are various types epidural needles which can be used. The needle is placed on the midline or a paramedian approach to the epidural space. Confirmation of the epidural space may be made by loss of resistance technique or a hanging drop technique prior to the injection of the agents. Complications associated with this technique, although rare, may be attributed to either the needle placement or the specific agent injected. Insertion of the needle may injure the epidural veins which may result in an epidural hematoma, and bacterial contamination may cause an epidural abscess or meningitis. If these are not recognized quickly and treated effectively, nerve damage or paralysis may occur. Injection of local anesthetics may cause hypotension secondary to sympathetic blockade. Since large volumes are often used, an unintentional subarachnoid injection may result in a total spinal anesthetic which would require circulatory and ventilatory support. Narcotics may cause respiratory depression immediately after injection or delayed respiratory depression up to 12 hours later. Any medication injected into the epidural space should be preservative free since most preservatives are considered neurotoxic.

Epidural injections were first reported in 1901 as treatment for lumbar nerve root compression.[2] There have been numerous reports since then trying to delineate indications and efficacy of epidural steroid injections(ESI). The difficulty and controversy that arises is due in part to the inability of most researchers to control the variables. This would include the cause of the symptoms, duration of symptoms, history of surgical procedure, previous treatments, and the treatments being evaluated. Even in comparing studies which are considered to be well designed, the results are inconsistent.[3] ESIs have been utilized in the treatment of annular tears, chronic lumbar degenerative disc disease, herniated nucleus pulposa (HNP) without neurologic deficits, HNP with nerve root irritation, HNP with nerve root compression, spondylolysis, spondylolisthesis, facet arthropathy, scoliosis, ankylosis spondylitis, spinal stenosis, functional low back pain, and back pain following spine surgery.[4,5] There have been varying success rates which are mostly dependent on the cause of the symptoms. Acute radiculopathies seem to respond to ESIs better than chronic conditions. Success rates range from 83% to 100% if the symptoms have been present for less than three months. This decreases to 67% to 81% at six months, and 46% if symptoms have been present greater than a year. This was reported in uncontrolled studies.[6,7,8,9,10] Dilke reports through a prospective, randomized, double blind study the efficacy of ESI in the treatment of patients with disc problems. They had follow up to six days after the ESI and used a volume of 10ml.[11] Another prospective, randomized, double blind study showed no statistical significance between the ESI and placebo, however, the objective and subjective feelings of improvement were higher in the ESI group.[12] The difference between these two studies was that 2 ml of the steroid solution was placed, and follow up evaluation occurred after two to three days compared to the larger volume and longer follow up period of Dilke. Complications from ESIs have consis-

tently been shown to be rare. Unintentional dural puncture occurs 1% of the time. Cushing' syndrome[13] and congestive heart failure[14] have been reported, but these are extremely rare.

Specific nerve root blocks with steroids may be placed with fluoroscopic guidance. This may be therapeutic as well as diagnostic.[15] If the patient has relief of his symptoms with a single nerve root injection, this would comfirm the level that may require surgical correction. Peripheral nerve blocks with local anesthetic may be used for diagnostic purposes prior to surgical, chemical or thermal neuroablation.[16] Neurolysis has been traditionally recommended for use in patients with life expectancies of less than one year. Chemical neurolysis may be accomplished with the injection of phenol 6% - 8% in glycerol or alcohol 33% - 100%. The effects of these solutions may include precipitation of lipoproteins and mucoproteins, disruption of myelin, extraction of cholesterol, and phospholipids, and coagulation of proteins. Duration of these injections range from three to six months before regeneration of the nerve tissue. Complications from these injections are usually due to injury to surroundings structures. Alcohol may be painful during the injection and cause an alcohol neuritis with high concentration injections. Phenol may cause convulsions and renal toxicity. Doses are to be kept below 100 mg. Thermal neuroablation includes cryoanalgesia and radiofrequency ablation. Both of these methods require the insertion of a probe to apply heat or cold to the neuron. The equipment required can be costly and requires knowledge of its use. Radiofrequency techniques will heat the nerve tissue to 60° C - 100° C for coagulation. Cryoanalgesia will cool the nerve tissue to -60° C for destruction of the myelin sheath. These techniques have minimal tissue damaged, lack of neuritis or neuroma formation, and cryoanalgesia is reversible after three to six months. Difficulties with these procedures include sensory and motor deficits that are bothersome to the patient and recurrence of their symptoms.

The sympathetic nervous system is frequently blocked with local anesthetics in the treatment of various pain syndromes. In addition to the sympathetic chain which is innervated with fibers from T1 to L3, there are several distinct ganglia which are of use in the treatment of pain. These include the stellate ganglion (SG), celiac plexus (CP), and the hypogastric plexus (HGP). Sympathetic blocks have been used in the treatment of circulatory insufficiency which includes Raynaud's syndrome, arterial embolism, and vasospasm, chronic regional pain syndrome, herpes zoster, pain due to abdominal malignancies, and phantom limb pain.[17]

The SG formed from fibers the first thoracic nerve and occasionally the second thoracic nerve. It provides sympathetic innervation to the head and upper extremity. The ganglion lies in front of the transverse process of the seventh cervical vertebra. The block is usually performed at the transverse process of the sixth cervical vertebra to minimize the risk of puncture to the vertebral artery and the dome of the pleura. Injection of 10 ml to 20 ml of local anesthetic is adequate for blockade of the SG. Horner's syndrome, ptosis, myosis, and enophthalmos, will indicate sympathetic blockade to the head, but not necessarily the upper extremity. Complications of this block may include temporary hoarseness, brachial plexus block, pneumothorax, verebral artery injection, seizures, hematoma, subarachnoid block, and injury to any of the surrounding anatomical structures.

The celiac plexus is made up of one to five discreet ganglia which derives its innervation from T5 to T12. It provides sympathetic innervation to the abdominal viscera, stomach, small bowel, large bowel to the splenic flexure, omentum, liver, gallbladder, pancreas, spleen, adrenal glands, and kidneys. The CP is located anterior to the aorta at the level of the celiac artery which corresponds to the T12 or L1 level. Blockade may be performed from an anterior or posterior approach. This may be accomplished by using anatomical landmarks, fluoroscopy, or CT guidance. Injection of 30 ml to 50 ml of local anesthetic will be sufficient to block the celiac plexus for diagnostic purposes. Neurolytic blocks with alcohol or phenol may be placed with CT guidance with greater precision. The classic example for this is the use of a neurolytic CP block in the treatment of pain associated with pancreatic cancer. Complications which may occur are diarrhea, hypotension, aortic or vena caval injection, renal puncture, and hematoma.

The HGP are formed from fibers from and lumbar sympathetic chain and aortic ganglia. It provides sympathetic innervation to the rest of the colon and the pelvic contents. The HGP is the most diffuse of the ganglia. It is located at the bifurcation of the common iliac arteries which is located at L5. Blockade of the HGP may be performed using anatomical landmarks, fluoroscopy, or CT guidance. Uterine or rectal pain due to unresectable malignancies have been treated effectively with this procedure.

The sympathetic chain itself, may be blocked with fluoroscopic guidance to the appropriate level to affect the ipsilateral side. Lumbar sympathetic blocks with 15 ml to 20 ml of local anesthetic are the most frequent block of this type This would be effective in treating disorders of a single lower extremity. The blockade of a single extremity may be beneficial in the patient who would not tolerate complete sympathetic blockade of both lower extremities that can occur with an epidural or subarachnoid block.

Chronic regional pain syndrome (CRPS), formerly referred to as reflex sympathetic dystrophy or sympathetic mediated pain is an uncommon pain syndrome which usually affects the extremities. CRPS may occur after an injury to the limb. The patient will develop a burning sensation which may or may not follow a specific nerve distribution. They will have hyperpathia, increased sensitivity, and allodynia, pain to a stimulus which is normally without pain. The affected limb has decreased blood flow which may result in decreased temperature and cyanosis. Eventually, there will be loss of hair and skin changes associated with ischemia. The limb becomes painful to move, and even wind blowing on the limb will cause excruciating pain. This leads to immobility, contractures, and loss of bone density. Treatments are aimed at early diagnosis and early aggressive treatment.[18] Sympathetic blocks or IV regional blocks with Guanethidine or Bretylium have been used as treatments for CRPS. Clonidine, an alpha-2 agonist, has also been used with success. Other treatments for neuropathic pain such as the antidepressant and anticonvulsant medications have been used. Physical therapy is an integral part of the patient's care to maintain range of motion and strength. If these modalities fail, implantable devices may be considered.

With advances in technology, dorsal column stimulators (DCS) have become a good therapeutic option in some patients. This may help to prevent a neuroablative procedure. DCS has been utilized in the treatment of failed laminectomies, CRPS diabetic neuropathy, ischemic pain and PHN.[19] Candidates for this therapy will have

failed other more conservative modalities including oral pharmacotherapy, nerve blocks, and TENS. Proper patient selection will be made prior to the implantation with the patient's pain pattern being at the center of *this* evaluation. A OCS electrode has one to eight leads on it, each of which can be programmed positive, negative, or off. The generator itself may also be programmed as one of the leads. The electrode may be placed percutaneously or via a hemilaminotomy. Final position will be attained with fluoroscopic guidance and verbal confirmation with the patient. The patient will have a trial of the DCS for one to two weeks. They should have at least a 50% reduction in their symptoms before deciding on the final placement of the subcutaneous generator. In this regard, there are two systems available. One is completely subcutaneous with the pulse generator/battery unit implanted on the abdominal wall or buttock. There is an external hand held unit to turn the DCS on, off, up, or down within the preprogrammed variables. The other system type has a generator coil implanted subcutaneously with an external telemetry Unit to provide the energy for stimulation. The external unit will utilize 9 volt batteries. Once the electrode has scarred in place, there should be minimal maintenance of the system. The patient should return to physical therapy for rehabilitation.

When the pain pattern covers more than several dermatomes, a DCS would be only partially effective. Spinal opioids would be next in the line of treatment modalities from less invasive to more invasive. Opioids administered into the epidural or intrathecal space have provided analgesia which is superior to that of parenterally administered opioids.[20] Neuraxial opioids have been used in post operative pain, cancer pain, herpes zoster, myocardial infarction, thrombophlebitis, ischemic pain, low back pain, obstetrics, and chronic regional pain syndrome to name a few. Intrathecal and epidural infusion will use much less medication than the oral route. Patients who were unable to take large doses of narcotics due to side effects may be able to tolerate the lower doses with improved pain relief.[21,22] Selection of the narcotic to be used is based on the pharmacodynamics and pharmacokinetics of the narcotic in the intrathecal or epidural space. Onset of action is shorter it the narcotic is more lipophilic, such as Fentanyl.

Morphine is a more hydrophilic narcotic and has a slower onset of action and longer duration of action that the other opioids. Neuraxial opioids may be administered as single shot doses or continuously through a catheter. Adverse effects of spinal opioids may occur at the time of injection. Epidural doses are larger than intrathecal doses by 10 to 16 times, and systemic side effects are more likely in the epidural route. Nonsystemic effects more commonly associated with neuraxial opioids are urinary retention, pruritis, and delayed respiratory depression. Pruritis can be treated effectively with antihistamines or naloxone. This usually disappears after several days. Naloxone and/or catheterization may be used in treating urinary retention. Early respiratory depression may occur from systemic absorption of opioids. Delayed respiratory depression may occur hours after administration of neuraxial opioids due to rostral spread in the cerebral spinal fluid. Although this is very rare, it is more common with hydrophilic narcotics compared to the more lipophilic narcotics. This is easily treated with small doses of Naloxone.

An epidural catheter may be tunnelled subcutaneously to decrease the incidence of infection, or it may be attached to a subcutaneous port. The intrathecal catheter may be connected to a subcutaneous infusion pump (SCIP). Narcotics are usually infused through these systems. Other medications such as Baclofen, Clonidine, and local anesthetics have also been placed in the epidural or intrathecal space via a SCIP. An epidural port infusion would require an external infusion pump and larger volumes with refills one to two times a week. An intrathecal infusion with a SCIP may be refilled every three months. The main consideration in choosing an epidural catheter with a subcutaneous port or intrathecal catheter with a subcutaneous infusion pump would be the life expectancy of the patient. Both modalities are very effective, but the cost of each system varies. The epidural and port system is inexpensive initially, but with time, the cost of medication, supplies, and nursing support will become greater than the cost of the subcutaneous infusion pump. These cost lines cross at approximately three months time. A patient with a life expectancy of three to six months should have an epidural catheter with a port, and a life expectancy of greater than three months should have the intrathecal catheter and subcutaneous infusion pump.

There are many options in the treatment of chronic pain. The majority of patients will respond to the more traditional therapies of oral pharmacotherapy or surgical correction of an anatomic abnormality that causes the pain. Up to 20% of patients will not respond well to these therapies. If these methods are ineffective or they cause adverse reactions, there are other treatment modalities available. Knowledge of these modalities will help to insure the adequate and compassionate care of the patient with intractable pain.

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